

UNITED STATES PATENT OFFICE

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METHOD OF NITRIFICATION

No Drawing.

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This invention relates to the production of thin layers of hard, wear-resistant, nitrogen-containing material on ferrous articles.

The production of a hard, adherent, wear-resistant skin or case of nitrogen-containing material on the surface of ferrous articles which contain certain alloy constituents by heating the articles in the presence of ammonia at comparatively low temperatures is known. For example, the case is commonly produced on aluminum-containing ferrous alloys which contain critical amounts of aluminum but the presence of other alloy constituents in critical amounts will produce nitrogen-containing wear-resistant cases on ferrous materials. To produce the case, the alloys may be heated in atmospheres of dry gaseous nitrogenous substances, such as ammonia, which give up nitrogen to the alloys. The temperatures generally used are about 450° C. to about 580° C., but other temperatures may be used. For the best results this process requires a treatment of fifteen to ninety hours at these temperatures in an atmosphere of ammonia to produce a wear-resistant nitrogen-containing skin of the required thickness. The time consumed in such a treatment necessitates a large amount of apparatus per unit of product and makes the process of nitrification costly. Where large articles are treated or a number of articles are treated together in the same container, a lack of uniformity of nitrification is a common occurrence. More rapid methods of producing the wear-resistant coatings and methods of producing more uniform coatings are desired.

It has been found that by covering or embedding the alloy article with non-metallic inert porous material and then heating in the above described atmospheres, the lack of uniformity described above is avoided and the rate of nitrification is greatly accelerated. The inert materials used are those which are infusible or do not decompose at the treating temperatures and which have no material effect on the alloys or ferrous materials when they are heated to the treating temperatures and ammonia is not present. The state of subdivision of the inert material varies the

rate of nitrification but comparatively coarse aggregates as well as extremely fine powders may be used. The presence of the inert material increases the rate of penetration of the nitrogen-containing case as well as the rate of formation of the nitrogen-containing case, but the exact nature of the action of the inert material is unknown to me.

Inert material in the form of powder which is fine enough to conform to the irregularities of the article is preferred. The inert material may be calcined, if desired, to remove the last traces of water, but this is not necessary where harmful amounts of water are not present. Experience has shown that powdered carbon, magnesia, silica or asbestos give exceptionally good results, but other inert materials, such as other alkaline earth oxides may be used.

As illustrative of my invention,

I. An alloy article containing 95.50% iron, 0.90% aluminum and small amounts of silicon, manganese, carbon, phosphorus, sulphur, nickel, molybdenum and chromium was placed in a closed container and embedded in calcined magnesia. The magnesia was powdered so as to pass a screen of 200 meshes to the inch. The air in the container was displaced with ammonia and the article was heated in the presence of the ammonia and the inert material to 460° C. for four hours. Upon cooling, the article was found to have a uniform, thin, adherent, wear-resistant, nitrogen-containing coating having a hardness greater than that corresponding to 1000 Brinell.

An alloy article like the article described in Example I was heated to the same temperature in the presence of ammonia for four hours but without the inert material. Substantially no hardening of the surface by nitrification was produced.

II. Articles were embedded in magnesia at the center and at the eight corners of a container and treated with ammonia as described in Example I. The differences in hardness of the surface layers of the articles were less than the hardness corresponding to 10 Brinell.

Articles of the same composition were sim-

- ilarly placed in the same container and treated with ammonia for a time sufficient to produce a hard nitrogenous coating but without the inert material. The differences in hardness of the surface layers of the article were that corresponding to 300 Brinell.
- My invention is not limited to the treatment of aluminum-containing steels. It has been found that the presence of the inert material accelerates the formation of the nitrogen-containing coatings on other steels amenable to case-hardening by nitrification.
- Longer treatments produce thicker layers of nitrified material on the alloys. Thicker layers of nitrogen-containing material are produced with the same conditions of temperatures and time when the inert material is present than when only ammonia is used.
- I claim:
1. The method of producing nitrogen-containing coatings on an alloy article which comprises embedding the article in a closed container in porous inert non-metallic material, passing into the container a gaseous substance which will give up nitrogen to the article, and heating. 70
 2. The method of producing nitrogen-containing coatings on an alloy article which comprises embedding the article in a closed container in at least one of the following hereindescribed porous inert materials: (carbon, magnesia, silica, asbestos), passing into the container a gaseous substance which will give up nitrogen to the article, and heating. 75
 3. The method of producing nitrogen-containing coatings on an alloy article which comprises embedding the article in a closed container in powdered magnesia, passing into the container a gaseous substance which will give up nitrogen to the article, and heating. 80
 4. The method of producing nitrogen-containing coatings on an alloy article containing iron which comprises heating the article in contact with a powder of inert non-metallic material and a gaseous substance which will give up nitrogen to the article. 85
 5. The method of producing nitrogen-containing coatings on an alloy article containing iron which comprises heating the article in contact with a powder of inert non-metallic material and ammonia. 90
 6. The method of producing nitrogen-containing coatings on an alloy article containing iron which comprises heating the article to temperatures of about 450° C. to about 580° C. in contact with a powder of inert non-metallic material and a gaseous substance which will give up nitrogen to the article. 95
 7. The method of producing wear-resistant nitrogen-containing coatings on ferrous articles containing a critical amount of alloy substance which will produce an adherent nitrogen-containing coating by heating in the presence of ammonia at temperatures below about 580° C., which comprises covering the surface to be hardened with porous inert non-metallic material and heating the article at said temperatures for about four hours in the presence of ammonia. 100
 8. The method of producing wear-resistant nitrogen-containing coatings on ferrous alloy articles containing a critical amount of alloy substance which will produce an adherent nitrogen-containing coating by heating in the presence of ammonia at temperatures below about 580° C., which comprises covering the surface to be hardened with powdered magnesia, and heating at said temperatures for about four hours in the presence of ammonia. 105
- In testimony whereof, I affix my signature. 110
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